(3) Estimation and Hypothesis Testing

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Outlines

- Overview
- Estimation
- Hypothesis Testing

Learning Outcomes

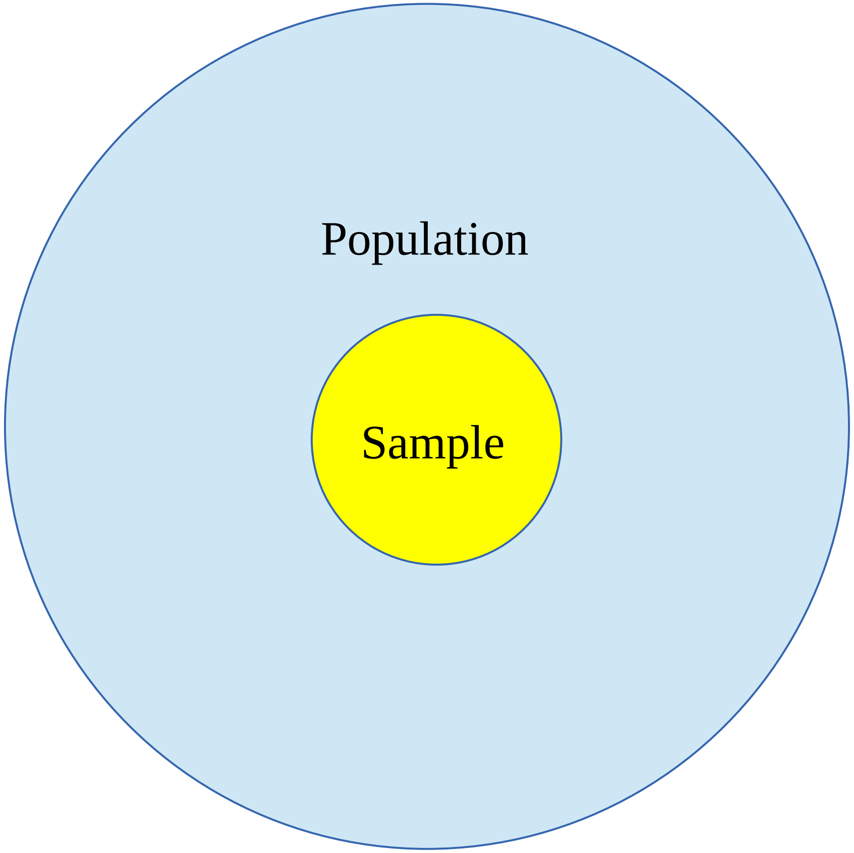
- Understand basic concept of confidence interval
- Able to interpret confidence interval
- Understand basic concept of hypothesis testing
- Able to interpret *P*-value
- Understand concept of significance level

Overview

- Statistics?
- Population vs sample?
- Inference?

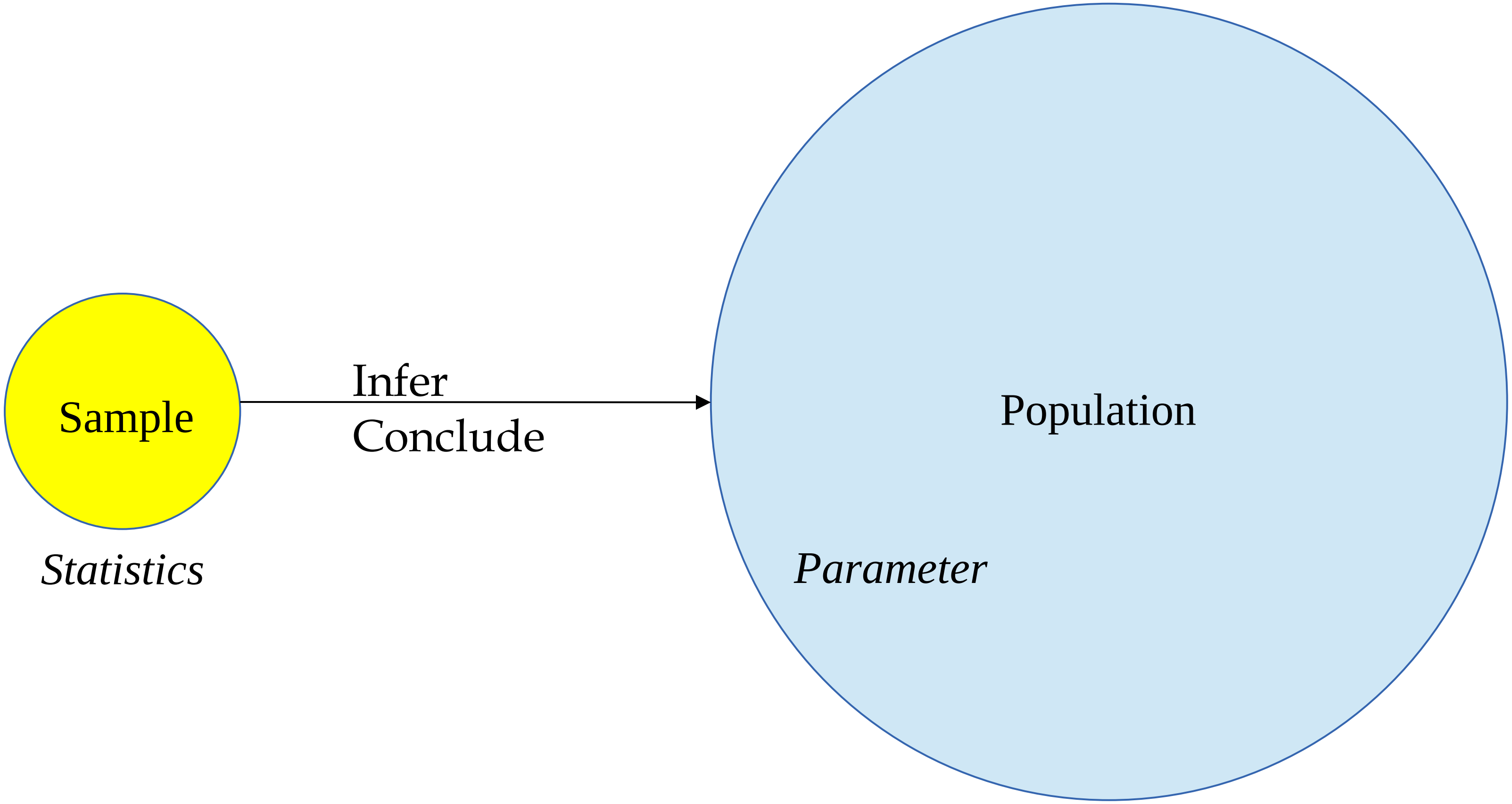
Overview

- Population *vs* sample

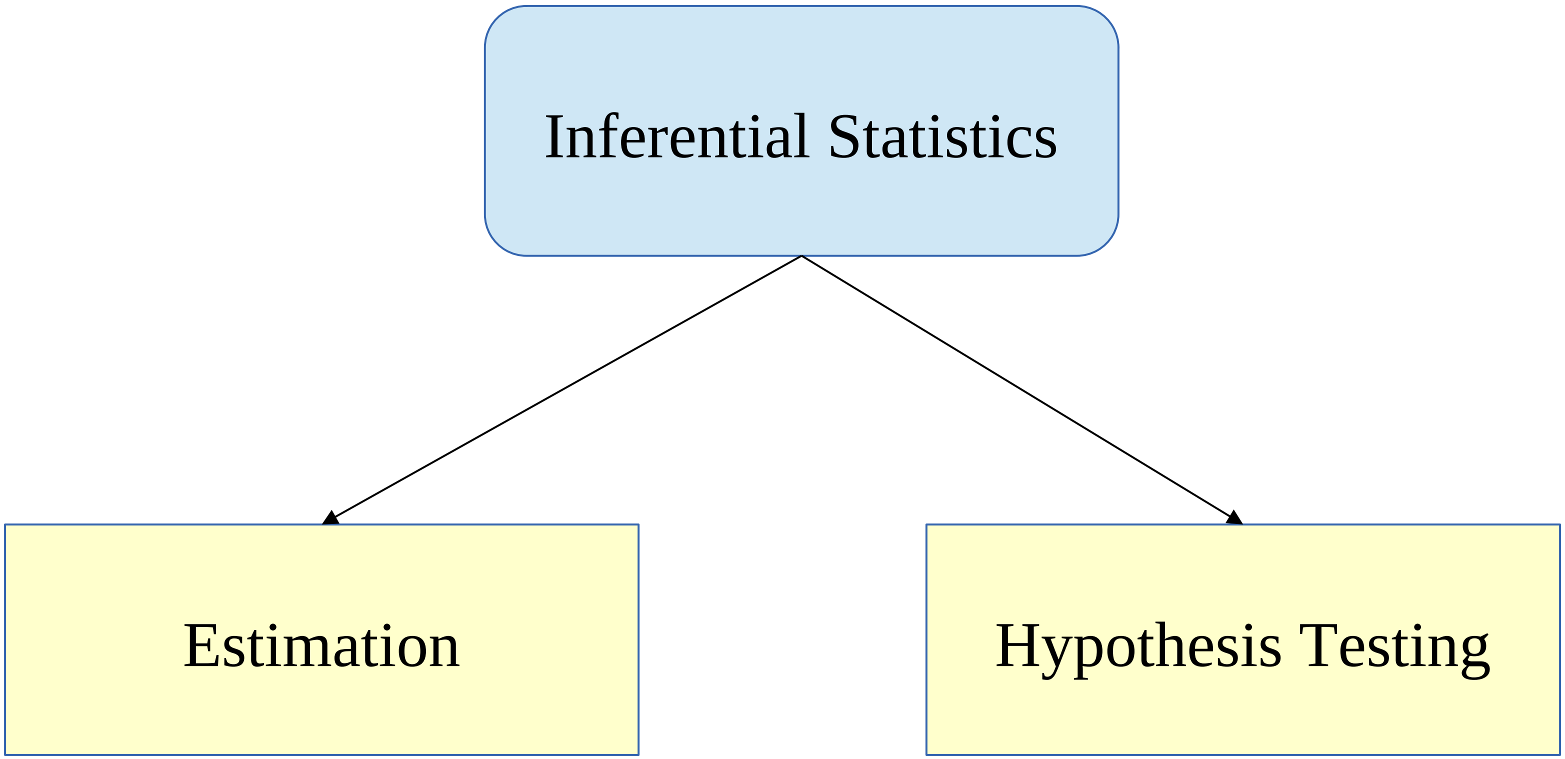


Overview

- Inference



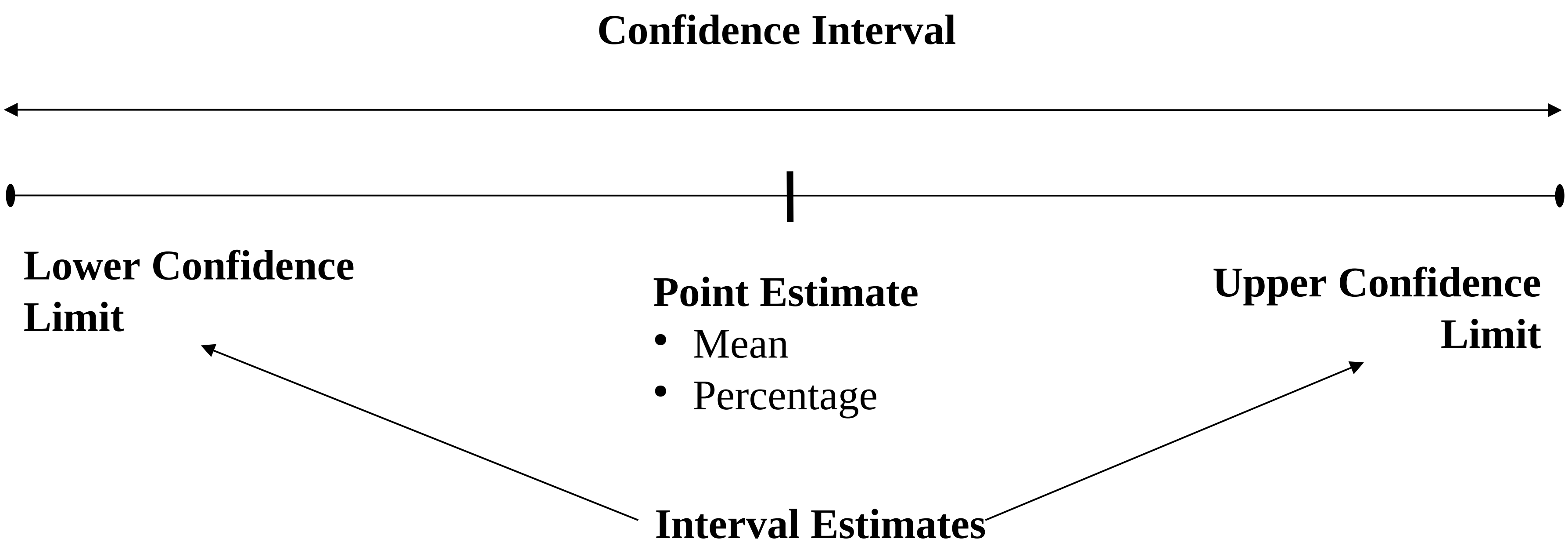
Overview



Estimation

Estimation

- Usually for <u>One Sample</u> → <u>One Population</u>
- Estimate *parameter* by



Estimation

<u>Mean SBP for Normal population</u>

95% Confidence Interval

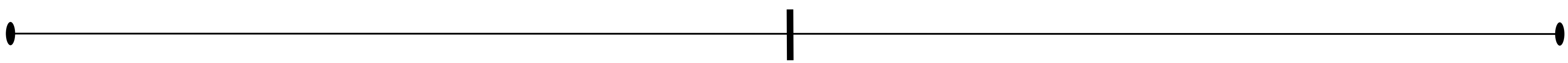
Interpretation: Based on a *sample* of 30 subjects, I am 95% sure that <u>mean SBP</u> of normal *population* is between 115mmHg to 125mmHg. The sample mean is 120mmHg.

Reporting: 120mmHg (95% CI: 115mmHg, 125mmHg)

Estimation

<u>Percentage of Obesity among University Students' population</u>

95% Confidence Interval



28% **38%** ***48%***

Interpretation: Based on a *sample* of 100 subjects, I am 95% sure that **<u>percentage of obesity</u>** of university students' *population* is between 28% to 48%. The sample percentage is 38%.

Reporting: 38% (95% CI: 28%, 48%)

Estimation

- **Interval estimates** values depend on ***Confidence level*** (90%, **<u>95%</u>**, 99%), ***sample size*** and ***standard deviation*** → Precision.
- Calculation?* Usually obtained from software output. It is important to know the interpretation.

*Estimation

- Interval estimates (mean):

Standard deviation

$$\text{Lower confidence limit} = \text{Point Estimate} - \text{Reliability Coeffient} \times \frac{SD}{\sqrt{n}}$$

Number of subjects

$$\text{Upper confidence limit} = \text{Point Estimate} + \text{Reliability Coeffient} \times \frac{SD}{\sqrt{n}}$$

*Estimation

- Interval estimates (proportion):

p = proportion

$$\text{Lower confidence limit} = \text{Point Estimate} - \text{Reliability Coeffient} \times \sqrt{\frac{p(1-p)}{n}}$$

Number of subjects

$$\text{Upper confidence limit} = \text{Point Estimate} + \text{Reliability Coeffient} \times \sqrt{\frac{p(1-p)}{n}}$$

*Estimation

- Reliability Coefficient:

Confidence level	Reliability coefficient, z
90%	1.65
95%	1.96
99%	2.56

Hypothesis Testing

Types of Hypothesis

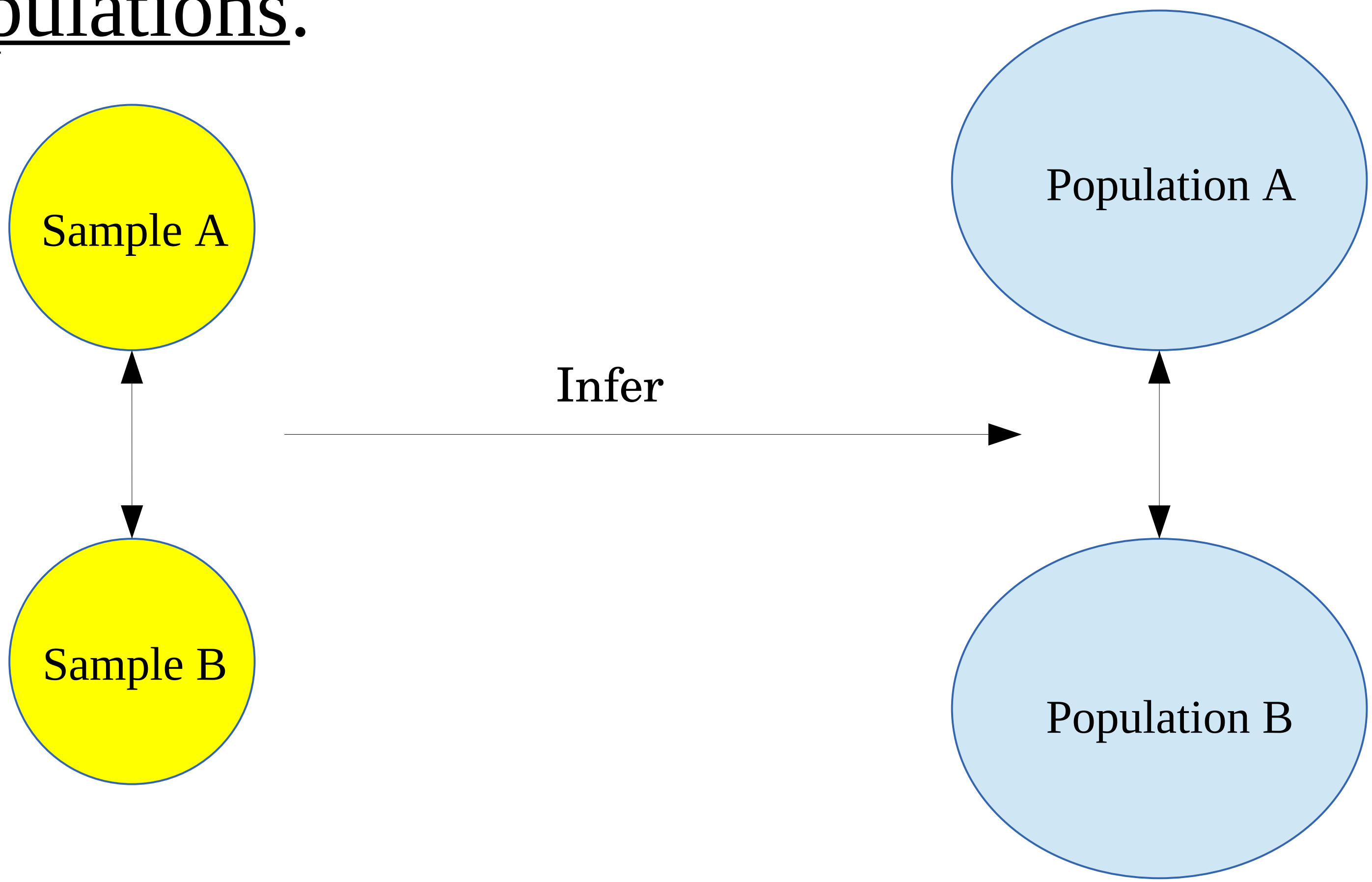
- Research hypothesis "is the conjecture or supposition that motivates the research"
- Statistical hypothesis is the hypothesis that is stated in a way that is possible to evaluate by appropriate statistical analysis

Types of Statistical Hypothesis

- Alternative hypothesis (H_A) – The inverse of H_0. It states a hypothesis of disagreement with the population of interest. In most situations, it reflect the proposition in the research hypothesis
- Null hypothesis (H_0) – It states a hypothesis of no difference/agreement with the population of interest

Hypothesis Testing

- Usually for <u>comparison of samples</u> → <u>comparison of populations</u>.



Hypothesis Testing

- Stated in form of **Statistical Hypothesis** → Can be tested with statistical test.

<u>Alternative Hypothesis</u>:
Population A is different from Population B

<u>Null Hypothesis</u>:
Population A is similar to Population B

Test Statistic

- Statistic obtained from our calculation using appropriate formula
- General formula for hypothesis testing

$$\text{test statistic} = \frac{\text{relevant statistic} - \text{hypothesized parameter}}{\text{standard error of relevant statistic}}$$

- Converted into probability value called ***P*-value** by referring to relevant statistical distribution (e.g. t, chi-squared and F distributions)

Hypothesis Testing

- ***P*-value** – Probability that the difference is merely by chance → low value means unlikely by chance
- Set acceptable level so called "chance" → **Significance level**, **α** (**<u>0.05</u>**, 0.01, 0.001)

<u>Alternative Hypothesis</u>:
P-value ≤ **0.05**

Null Hypothesis Rejected

<u>Null Hypothesis</u>:
P-value > **0.05**

Null Hypothesis not Rejected

Hypothesis Testing

Alternative Hypothesis:
Population A is different from Population B

Null Hypothesis:
Population A is similar to Population B

Statistical Test $\longrightarrow$

Alternative Hypothesis:
P-value ≤ **0.05**

Null Hypothesis:
P-value > **0.05**

Hypothesis Testing

Comparing **Mean SBP** of **Diabetic population** vs **Non-diabetic population**

<u>Alternative Hypothesis</u>:
Mean SBP of DM population is different from non-DM population

<u>Null Hypothesis</u>:
No difference in Mean SBP between the populations

Statistical Test →

<u>Alternative Hypothesis</u>:
P-value ≤ **0.05**

<u>Null Hypothesis</u>:
P-value > **0.05**

Independent t-test

Hypothesis Testing

Association between **Obesity** (Yes / No) and **Diabetes** (DM / No DM)

<u>Alternative Hypothesis</u>:
Obesity is associated with diabetes

<u>Null Hypothesis</u>:
Obesity is NOT associated with diabetes

Statistical Test

<u>Alternative Hypothesis</u>:
P-value ≤ **0.05**

<u>Null Hypothesis</u>:
P-value > **0.05**

Chi-squared test

Statistical Test vs Hypothesis*

		Hypothesis state (Truth)	
		True H_A False H_0 (Difference +)	True H_0 False H_A (Difference –)
Statistical test result	Significant (Test +)	True Positive $1 - \beta$ Sensitivity/**Power**	False Positive α **Type I Error**
	No significant (Test –)	False Negative β **Type II Error**	True Negative $1 - \alpha$ Specificity

Quiz

- Describe the concept of confidence interval and confidence limits
- List three common confidence levels
- Interpret the following statement:

The prevalence of diabetes among XYZ population is 25.3% (95% CI: 22.8%, 27.8%)

Quiz

- Describe two hypothesis statements in statistical hypothesis
- Describe the following terms:
  - Significance level
  - *P*-value
  - Type I and Type II errors
- "Based on the statistical test, the comparison was ______________ with a *P*-value of 0.021"

Thank You